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A NEW APPROACH FOR ESTIMATING ENTRAINMENT RATE IN CUMULUS AND PARAMETERIZATION IN MODELS

Chunsong Lu[1, 2], Yangang Liu[1], Seong Soo Yum[3], Shengjie Niu[2], and Satoshi Endo[1]

1 Atmospheric Sciences Division, Brookhaven National Laboratory (BNL), NY 11973
2 School of Atmospheric Physics, Nanjing University of Information Science and Technology (NUIST), Jiangsu, China 210044
3 Department of Atmospheric Sciences, Yonsei University, Seoul, Korea 120-749

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ABSTRACT

Entrainment of dry air into clouds is essential to many cloud processes, affecting cloud microphysical properties, cloud radiative properties, and evaluation of aerosol indirect effects, but it is still poorly understood and represented in atmospheric models. In an effort of the FASTER project to integrate aircraft measurements into model evaluation and parameterization development, here we present a new approach for estimating fractional entrainment rate in cumulus clouds from aircraft observations. This approach is based on the definition of fractional entrainment rate and the mass ratio of the adiabatic cloudy air to the dry air entrained during the ascent from cloud base to aircraft observation level. The essence of this approach is that the mass ratio is not calculated directly from the air masses, but is determined indirectly from the microphysics and thermodynamics along the observation level. This approach is applied to one flight of the RICO (Rain in Cumulus over the Ocean) where entrainment rate was calculated in a previous study with a traditional approach. Comparison between the results from these two approaches shows substantial consistency in terms of the vertical trend of entrainment rate. The average entrainment rate of all observation levels from this approach is comparable to the results in other previous studies. This approach has a potential to straightforwardly connect the studies of entrainment rate and microphysical effect of entrainment-mixing process (homogeneous/inhomogeneous entrainment-mixing mechanisms), improving the parameterization of entrainment-mixing process in models.